ISSN: 2278 – 909X
International Journal of Advanced Research in Electronics and Communication Engineering (IJARECE)
Volume 5, Issue 1, January 2016

A review paper on EDGE detection with comparative analysis of different edge detection approaches

Aprajita Chaturvedi
Dr.CV Raman University
Kargi road kota Biaspur (CG)

Ravi Tiwari
Dr.CV Raman University
Kargi road kota Biaspur (CG)

***Abstract*—An edge in an image is a contour across which the brightness of the image changes abruptly. In image processing, an edge is often interpreted as one class of singularities. In a function, singularities can be characterized easily as discontinuities where the gradient approaches infinity. However, image data is discrete, so edges in an image often are defined as the local maxima of the gradient. This is the definition we will use here. Edge detection is an important task in image processing. It is a main tool in pattern recognition, image segmentation, and scene analysis. An edge detector is basically a high pass filter that can be applied to extract the edge points in an image. The effectiveness of many image processing also computer vision tasks depends on the perfection of detecting meaningful edges. It is one of the techniques for detecting intensity discontinuities in a digital image. In this paper we will present a review on edge detection process.**

Index Terms - digital image processing, EDGE detection, sobel operator

I. Introduction

In imaging science, image processing is any form of signal processing for which the input is an image, such as a photograph or video frame; the output of image processing may be either an image or a set of characteristics or parameters related to the image. Most image-processing techniques involve treating the image as a two-dimensional signal and applying standard signal-processing techniques to it.Image processing usually refers to digital image processing, but optical and analog image processing also are possible.

An image defined in the “real world” is considered to be a function of two real variables, for example, a(x,y) with a as the amplitude (e.g. brightness) of the image at the real coordinate position (x,y).

Modern digital technology has made it possible to manipulate multi-dimensional signals with systems that range from simple digital circuits to advanced parallel computers. The goal of this manipulation can be divided into three categories:

- Image Processing (image in -> image out)
- Image Analysis (image in -> measurements out)
- Image Understanding (image in-> high-level description out)

An image may be considered to contain sub-images sometimes referred to as regions-of-interest, ROIs, or simply regions. This concept reflects the fact that images frequently contain collections of objects each of which can be the basis for a region. In a sophisticated image processing system it should be possible to apply specific image processing operations to selected regions. Thus one part of an image (region) might be processed to suppress motion blur while another part might be processed to improve color rendition.

Most usually, image processing systems require that the images be available in digitized form, that is, arrays of finite length binary words. For digitization, the given Image is sampled on a discrete grid and each sample or pixel is quantized using a finite number of bits. The digitized image is processed by a computer. To display a digital image, it is first converted into analog signal, which is scanned onto a display.

Closely related to image processing are computer graphics and computer vision. In computer graphics, images are manually *made* from physical models of objects, environments, and lighting, instead of being acquired (via imaging devices such as cameras) from *natural* scenes, as in most animated movies. Computer vision, on the other hand, is often considered *high-level* image processing out of which a machine/computer/software intends to decipher the physical contents of an image or a sequence of images (e.g., videos or

ISSN: 2278 – 909X
International Journal of Advanced Research in Electronics and Communication Engineering (IJARECE)
Volume 5, Issue 1, January 2016

3D full-body magnetic resonance scans). In modern sciences and technologies, images also gain much broader scopes due to the ever growing importance of scientific visualization (of often large-scale complex scientific/experimental data). Examples include micro array data in genetic research, or real-time multi-asset portfolio trading in finance.

Before going to processing an image, it is converted into a digital form. Digitization includes sampling of image and quantization of sampled values. After converting the image into bit information, processing is performed. This processing technique may be Image enhancement, Image restoration, and Image compression.

Image enhancement:

It refers to accentuation, or sharpening, of image features such as boundaries, or contrast to make a graphic display more useful for display & analysis. This process does not increase the inherent information content in data. It includes gray level & contrast manipulation, noise reduction, edge crispening and sharpening, filtering, interpolation and magnification, pseudo coloring, and so on.

Image restoration:

It is concerned with filtering the observed image to minimize the effect of degradations. Effectiveness of image restoration depends on the extent and accuracy of the knowledge of degradation process as well as on filter design. Image restoration differs from image enhancement in that the latter is concerned with more extraction or accentuation of image features.

Image compression:

It is concerned with minimizing the number of bits required to represent an image. Application of compression are in broadcast TV, remote sensing via satellite, military communication via aircraft, radar, teleconferencing, facsimile transmission, for educational & business documents, medical images that arise in computer tomography, magnetic resonance imaging and digital radiology, motion, pictures, satellite images, weather maps, geological surveys and so on.

Image processing is defined as the manipulation of image representation stored on a computer. Operations on images that are considered a form of image processing include zooming, converting to gray scale, increasing or decreasing image brightness, red-eye reduction in photographs, edge and shape detection of an object and always possible for every customers or students to be able to get this up-to-date information.

Edge detection is the name for a set of mathematical methods which aim at identifying points in a digital image at which the image brightness changes sharply or, more formally, has discontinuities. The points at which image brightness changes sharply are typically organized into a set of curved line segments termed *edges*. The same problem of finding discontinuities in 1D signals is known as step detection and the problem of finding signal discontinuities over time is known as change detection. Edge detection is a fundamental tool in image processing, machine vision and computer vision, particularly in the areas of feature detection examples of operators such as Canny, Sobel, Kayyali,..etc. and feature extraction. Points in an image where brightness changes abruptly are called edges or edge points. There are different types of sharp changing points in an image. Edges can be created by shadows, texture, geometry, and so forth. Edges can also be defined as discontinuities in the image intensity due to changes in image structure. These discontinuities originate from different features in an image. Edge points are to be associated with the boundaries of objects and other kinds of changes. Edges within an image generally occur at various resolutions or scales and represent transitions of different degree, or gradient levels. Edge detection refers to the process of identifying and locating sharp discontinuities in an image. There are many ways to perform edge detection. However, most of them may be grouped into two categories, namely, gradient based edge detection and Laplacian-based edge detection. In the gradient based edge detection, we calculate an estimate of the gradient magnitude using the smoothing filter and use the calculated estimate to determine the position of the edges. In other words the gradient method detects the edges by looking for the maximum and minimum in the first derivative of the image. In the Laplacian method we calculate the second derivative of the signal and the derivative magnitude is maximum when second derivative is zero. In short, Laplacian method searches for zero crossings in the second derivative of the image to find edges.

An edge map detected from its original image contains major information, which only needs a relatively small amount of memory space to store. The original image can be easily restored from its edge map. Various edge detection algorithms have been developed in the process of finding the perfect edge detector. Some of the edge detection operators are Robert, Prewitt, Sobel, FreiChen and Laplacian Of Gaussian (LOG) operators. Prewitt, Sobel and FreiChen are 3x3 masks operators. The Prewitt masks are simpler to implement than the Sobel masks, but the later have slightly superior noise suppression characteristics. LOG is a more complicated edge detector than the previous mentioned operators.

II. LITERATURE REVIEW

Edge detection refers to the process of identifying and locating sharp discontinuities in an image . Edge detection technique is usually applied on gray–scale image. The discontinuities are abrupt changes in pixel intensity which characterize boundaries of objects in a scene. Classical methods of edge detection involve convolving the image with an operator (a 2-D filter), which is constructed to be sensitive to large gradients in the image while returning values of zero in uniform regions.. Similar work has been already done by many people around the world.

The authors in [2] developed an kind of parallel processing construction of Sobel edge detection enhancement algorithm In this paper author used the old Sobel edge detection concept. In this work author use in the place of square unit he used absolute technique which will reduce some amount of timing and hardware complexity. Drawback of these approach is also present modified old existing approach in hardware. Due to using of modified old approach there is still large hardware unit is require..

The authors in [3] proposed a new approach for detection of edge on noisy image. In this work they combine sobel edge detection and WAVELET THRESHOLD DE-NOISING approach. But drawback of these approach is due to combination of two approach there is large hardware unit with height time complexity is require.

These authors [5] presents the proposed Sobel edge detection operator is model using of Finite State Machine (FSM) which executes a matrix area gradient operation to determine the level of variance through different of pixels In this paper author used the old Sobel edge detection concept.

The authors in [1] use Standard Sobel operators, for a 3×3 neighborhood, each simple central gradient estimate is vector sum of a pair of orthogonal vectors .Each orthogonal vector is a directional derivative estimate multiplied by a unit vector specifying the derivative's direction. The vector sum of these simple gradient estimates amounts to a vector sum of the 8 directional derivative vectors

The authors in [4] presents, a dedicated edge detection processor architecture based on field programmable gate arrays is presented. The architecture is an optimization of the Sobel edge detection filter, specifically focusing on the reduction of the computation time. The proposed architecture reduces the number of calculations required for the edge detection process by enhancing the data reuse, i.e. minimizing the frequency of memory access. Direct hardware implementation as proposed by previous works require most image pixels to be read from memory up to six times and transferred into the Sobel edge detection processor. In this work, author try to reduce the number of pixels read therefore affecting tremendous potential speed suitable for the embedded video processing applications.

The author in this[6] uses, a modified fuzzy Sobel method for edge detection and enhancement is proposed. This method is a modification for Fuzzy Sobel method. The proposed method overcomes the drawbacks of the conventional gradient methods for edge detection such as Prewitt and Sobel methods. it automatically obtains four threshold values, and apply fuzzy reasoning for edge enhancement. The edges extracted by this method are very clear and provides better representation for image edges and object contours.

The author in this[7] discuss the Sobel edge detection prohibit of operator ,The edge detection operator effect solve the problem of positioning ,Using the high-pass Butterworth filter. The authors in [8] used an improved method of Sobel operator. In addition, making use of fusion technology, a kind of method combined with improved Sobel operator, wavelet transform. Experiments show that the fusion image effectively improves the accuracy of edge detection and gets a quite ideal edge detection effect.

III.RESEARCH GAP

There is lots of issue in previous existing edge detection algorithm. Those issues are divide in two level, which are followings:

Algorithmic Level:

According to previous existing edge detection algorithms have many issues. Some approach are face the issue of quality so some will face the issue of time complexity.

- Time Complexity
- Memory Complexity
- Quality Issue.

Architecture Level:

- Power Complexity
- Memory Complexity
- Speed Complexity
- Area Complexity

IV. METHODOLOGY

The proposed method is implemented on matlab to thoroughly investigate the required time to detect edges with in an object and compare output image with various parameters . Here we will use grayscale image and we will find sobel edge detection with improved filter based technique and here for filter we are using approximate 2D Gaussian filter.

Sobel Operator

Sobel operator is a pair of 3x3 convolution kernels as shown in Figure 2.4 [1]. The second kernel is obtained by rotating the first by 90; the two kernels are orthogonal to each other. These kernel values are designed for maximum response to edges running vertically and horizontally relative to the pixel grid, one kernel for each of the two perpendicular orientations. One can apply kernels separately to the input image, in order to produce separate measurements of the gradient component in each orientation (known as Gx and Gy). These can then be combined together to find the absolute magnitude of the gradient at each point and the orientation of that gradient. The gradient magnitude is given by Equation . The angle of orientation of the edge (relative to the pixel grid) giving rise to the spatial gradient is given by,

$$\theta = \tanh^{-1}\frac{G_X}{G_Y}$$

-1	0	+1
-2	0	+2
-1	0	+1

Gx

+1	+2	+1
0	0	0
-1	-2	-1

Gy

Figure 1 The convolution kernel for the Sobel Edge detector. Note the emphasis on the horizontal and vertical edges

The gradient magnitude is given by:

$$|G| = \sqrt{Gx^2 + Gy^2}$$

Although typically, an approximate magnitude is computed using:

$$|G| = |Gx| + |Gy|$$

which is much faster to compute. And the angle of orientation is given by:

$$\theta = \arctan\left(\frac{Gy}{Gx}\right) - 3\pi/4$$

In this case, orientation 1 is taken to mean that the direction of maximum contrast from black to white runs from left to right on the image, and other angles are measured anticlockwise from this.

Parameter comparison:

Various parameters are used to evaluate the proposed algorithm at both levels. The various parameters are

1. PSNR (Peak signal-to-noise ratio)
2. SSIM(structural-similarity-based image quality assessment)
3. FSIM(Feature Similarity Index for Image Quality Assessment)

V. APPLICATIONS

Edge detection is basically used for finding Sharpe edges of any image and video, this is used in many applications like in 2D to 3D conversion technique for generation of depth map.It is used in medical image processing like object recognition of the human organs. It is used in automatic driving technique, face detection approach identifies human faces in digital image ,in image navigation.

VI. CONCLUSION

In this paper our main target is to reduce the time complexity issue which is already faced by previous existing technique. So here we will design our error tolerant edge detection algorithm by using of Sobel concept & for noise reduction we will use Gaussian 2D smooth filter .

VII. ACKNOWLEDGMENT

The authors would like to thank the Department of ECE at DR. C. V. RAMAN UNIVERSITY for facilitating the development of the project, making available resources for testing the system and also for final deployment.

VIII. REFERENCES

[1] Nita, I.; Costachioiu, T.; Lazarescu, V.; Seceleanu, T., "Multiprocessor real time edge detection using FPGA IP cores," *Intelligent Computer Communication and Processing (ICCP), 2011 IEEE International Conference on* , vol., no., pp.331,334, 25-27 Aug. 2011

[2] Zhengyang Guo; Wenbo Xu; ZhiLei Chai, "Image Edge Detection Based on FPGA," *Distributed Computing and Applications to Business Engineering and Science (DCABES), 2010 Ninth International Symposium on* , vol., no., pp.169,171, 10-12 Aug. 2010

[3] Wenshuo Gao; Xiaoguang Zhang; Lei Yang; Huizhong Liu, "An improved Sobel edge detection," *Computer Science and Information Technology (ICCSIT), 2010 3rd IEEE International Conference on* , vol.5, no
.

[4]Osman, Z.E.M.; Hussin, F.A.; Ali, N.B.Z., "Optimization of Processor Architecture for Image Edge Detection Filter," *Computer Modelling and Simulation (UKSim), 2010 12th International Conference on* , vol., no., pp.648,652, 24-26 March 2010

[5] Zhao Chunjiang; Deng Yong, "A Modified Sobel Edge Detection Using Dempster-Shafer Theory," *Image and Signal Processing, 2009. CISP '09. 2nd International Congress on* , vol., no., pp.1,4, 17-19 Oct. 2009

[5] Yasri, I.; Hamid, N. H.; Yap, V. V., "Performance analysis of FPGA based Sobel edge detection operator," *Electronic Design, 2008. ICED 2008. International Conference on* , vol., no., pp.1,4, 1-3 Dec. 2008

[6] El-Khamy, S.E.; Lotfy, M.; El-Yamany, N., "A modified fuzzy Sobel edge detector," *Radio Science Conference, 2000. 17th NRSC '2000. Seventeenth National* , vol., no., pp.C32/1,C32/9, 2000

[7] Zhong Zhang; Geng Zhao, "Butterworth filter and Sobel edge detection to image," *Multimedia Technology (ICMT), 2011 International Conference on* , vol., no., pp.254,256, 26-28 July 2011

[8] Caixia Deng; Weifeng Ma; Yin Yin, "An edge detection approach of image fusion based on improved Sobel operator," *Image and Signal Processing (CISP), 2011 4th International Congress on* , vol.3, no., pp.1189,1193, 15-17 Oct. 2011

[9] R. Biswas and J. Sil, "An Improved Canny Edge Detection Algorithm Based on Type-2 Fuzzy Sets," Procedia Technology, vol. 4, no. 0, pp. 820 – 824, 2012

[10]Lin Zhang; Zhang, D.; Xuanqin Mou; Zhang, D., "FSIM: A Feature Similarity Index for Image Quality Assessment," *Image Processing, IEEE Transactions on* , vol.20, no.8, pp.2378,2386, Aug. 2011.